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MILO STOVER AS AN ENERGY SOURCE FOR GROWING BEEF HEIFERS AND LAMBS

by

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INTRODUCTION

The world population is outgrowing its food supply, and protein threatens to become the first limiting nutrient. A possible solution is the conversion of plant residues and non-protein nitrogen into animal protein. While farmers grow near maximum yields of grain, relatively few use grain crop residues for livestock feed. Crop residues, while not digested by monogastrics, can be utilized, with proper nitrogen supplementation, by ruminants for maintenance or, possibly, weight gain.

Crop residues have considerable energy in the form of simple sugars and polysaccharides. The polysaccharides are present in cell walls in the form of cellulose and hemicellulose. Although cellulose is protected from degradation by its 1, 4 glycoside linkages, rumen microflora are able to digest it if lignification is not too great. Lignification is the major difference between high and low quality roughages. High-quality roughages (alfalfa hay or corn silage) have less lignification than low-quality forages (wheat straw or corn stover).

Non-protein nitrogen sources have contributed greatly to increased production of cattle and sheep since rumen microbes can synthesize amino acids from ammonia. This reduces animal production costs by replacing expensive natural proteins.

To increase the utilization of grain crop residues, more efficient systems of both harvest and nitrogen supplementation are needed.

This study was initiated primarily to determine the feeding value of milo stover for growing beef heifers and lambs.

REVIEW OF LITERATURE

Forage Composition and Quality

Forage carbohydrates can be separated according to their solubility in neutral detergent, into cell contents and cell wall constituents (Van Soest, 1963). Van Soest (1969) reported that cell contents (the neutral detergent soluble portion) often exceed 50 percent of the forage dry matter and are of high nutritive availability. Cell wall constituents (insoluble in neutral detergent) are the fibrous portion of the cell wall and are largely indigestible to non-ruminants since these animals do not secrete enzymes capable of digesting complex carbohydrates. Microorganisms in the rumen are capable of converting these complex carbohydrates to simpler chemical compounds which are readily utilized by the host animal.

Cell wall constituents include lignin, cellulose and hemicellulose. Lignin increases from about 2% in immature forages to as much as 15% in mature forages. Baker and Harriss (1947) reported that lignin supplies strength and rigidity to plants. Since it is indigestible even to ruminants, it not only acts as an inert diluent; but because of its close physical and chemical association with the cell wall polysacchrides, it acts as a physical barrier and impedes their microbial digestion.

Cellulose is the most abundant polysaccharide of the cell wall constituents and the most insoluble (Timell, 1964). It is a polymer of glucose units and the degree of polymerization varies within and between sources of cellulose.

In vitro cellulose digestion an estimate of dry matter digestibility has been used to estimate forage quality (Quicke and Bentley, 1959; Quicke and Bentley, 1958; Sullivan, 1955; Tomlin, Dehority and Johnson, 1961; and Johnson *et al*., 1962). Van Soest (1967) observed that cellulose is seldom more than one-third of the plant dry matter or roughly one-half of the total plant cell wall. However, since the proportion of cellulose to lignin and hemicellulose varies widely, cellulose may not be representative of the fibrous constituents of the forage.

Cellulose levels in legumes and grasses tend to be similar (Van Soest, 1967), but grasses may contain up to four times as much hemicellulose.

Hemicellulose is an amorphous polysaccharide which includes short-chained glucans, polymers of xylose, arabinose, mannose and galactose plus mixed sugar and uronic acid polymers (Roelofsen, 1959). It exists in close association with cellulose and lignin and is generally separated from cellulose by extraction with dilute alkali and acid (Jarrige, 1960; Waite, 1963; Van Soest, 1967). Sullivan (1966) reported that hemicellulose is just as important as cellulose in influencing the quantity of energy obtained from the fibrous constituents of a forage.

As a plant matures, its digestibility decreases (Noler *et al*., 1960; Meyer *et al*., 1957; Schneider, Soni and Ham, 1953; Weir, Jones and Meyer, 1960; Lloyd *et al*., 1961; Danley and Vetter, 1973), and its relative proportion of cell wall constituents and cell contents change

(Danley and Vetter, 1973). Van Soest (1966) reported that cell wall constituents were 15 percentage units higher in late-cut alfalfa than early-cut alfalfa. The cell wall constituents of early-cut orchard-grass hay were 52.3% of the total plant, increasing to 70.4% in late-cut hay (Van Soest, 1964).

Blaser (1964) observed that as a forage develops from early bud stage to full maturity, the protein content and digestibility decrease and lignin increases. Phillips et al., (1954) suggests that the decrease in digestibility and subsequent decrease in nutritive value is due to increases in both fiber constituents and lignin and a decrease in crude protein.

Since lignin is not digested by ruminants (Crampton and Maynard, 1938; Gray, 1947) and it increases in forages with maturity, changes in lignin may explain the poor feeding value of mature forages. Baker and Harriss (1947) suggested that lignification is a physical barrier to cellulose digestion by cellulolytic rumen microorganisms, acting as an "encrusting substance" and thus preventing enzymes of the rumen microorganisms and intestinal digestive juices from attacking plant nutrients.

The development of the in vitro or "artificial rumen" technique enabled studies on the relationship of lignin as an "encrusting substance" to the digestibility of forage samples and served as an estimate of forage digestibility (Burroughs et al., 1950; Bentley et al., 1954; Tilley and Terry, 1963).

Forbes and Garrigus (1948; 1950 a, b) reported significant correlations between the lignin content, and dry matter, or organic matter digestibility and total digestible nutrients. Kamstra, Moxon and Bentley (1958) demonstrated that the digestibility of plant cellulose decreased as the lignin content of the forage increased.

Sullivan (1955) found forage cellulose and lignin increased with advancing maturity. As lignin increased, cellulose digestibility decreased. Tomlin, Johnson and Dehority (1965) reported lignin content was negatively correlated with 12 hour in vitro cellulose digestibility for grasses and legumes, although the regression equations for the two forages were significantly different.

Dehority, Johnson and Conrad (1962) used timothy, alfalfa and orchard grass as substrates to study in vitro hemicellulose fermentation. In all cases, extent of hemicellulose fermentation decreased as the plants matured. When forage particle size was reduced by ball-milling (an attempt to remove barrier digestion inhibition by lignin) hemicellulose fermentation increased. Pectin fermentation followed a similar trend.

The relationship of lignin to cellulose digestibility also depends upon plant species (Van Soest, 1962). Quicke and Bentley (1958) observed that cellulose digestibility in mature brome and orchard grass hays differed considerably although proximate composition and lignin were similar. Later, Quicke and Bentley (1959) suggested differences in the lignin content of mature forages were too small to account for the observed differences in cellulose digestibility.

Voluntary Intake

Crampton (1957) and Crampton, Donefer and Lloyd (1960) reported that the feeding value of a forage depends upon the quantity voluntarily consumed as well as its digestibility. Conrad (1964) proposed that voluntary feed intake was related to the dry matter digestibility. Consumption of feed of low digestibility (52-60%) is regulated by animal capacity, the passage rate of feed and its digestibility. Conrad (1966) also suggests that environmental temperature and chemostatic regulators influence feed intake, with chemostatic regulation dominant in feed of high digestibility. Van Soest (1965) reported that high levels of cell wall constituents or fibrous mass decrease forage intake, particularly where cell wall constituents are over 50 to 60% of the forage dry matter.

Blaxter, Wainmann and Wilson (1961) observed that in forages ranging from 38 to 70% in digestibility, consumption is positively correlated with digestibility. In forages over 70% digestible, voluntary intake varied with a fractional power of body weight close to 0.734, providing a rapid and easy method for determining forage quality when offered ad libitum.

Conrad (1964) found voluntary intake was related to rate of passage and body weight when rations of low digestibility were fed to lactating dairy cows. In higher digestible rations, intake was related to milk production, digestibility and metabolic size of the animal.

Balch and Campling (1962) reported that the rate of removal of undigested residue from the digestive tract influences intake, and this may be influenced by particle size. Lloyd et al., (1960) and O'Dell et al., (1962) observed increased consumption when forage particle size was reduced by pelleting, chopping or grinding. Weeb and Omarik (1957) fed steer calves a mixed timothy-alfalfa ration and found a 50% increase in daily dry matter intake when pelleted hay was compared to unprocessed, baled hay. Ronning et al., (1959) observed 26% more dry matter intake when pelleted hay was compared to chopped hay, each fed as the only ration to milk cows. Murdock (1965) and Owen and Kuhlman (1967) indicated dry matter intake was increased by decreasing particle size of silage. Moore (1964), Minson (1963), Beardsley (1964), Meyer et al., (1959) and Putman and Davis (1963) concluded that reducing particle size may not only increase voluntary intake but also decrease crude fiber digestibility.

Feeding Value of Grain Crop Residues

Interest in utilizing crop residues was first shown in the early 1900's. Sherman and Bechdel (1918) reported that corn stover fermented to a product quite similar to corn silage. Cattle preferred stover silage to any dry roughages. Nevens and Harshbarger (1941) reported that ensiling broomcorn stover with molasses produced good quality silage. When it was compared to corn silage, milk production in dairy cows was only slightly reduced. Dowell and Friedemann (1921) reported that broomcorn silage kept in good condition, had a pleasant odor, was eaten with relish by sheep and had a dry matter digestibility of 51.5%.

Cox (1929) observed in a 92-day lamb growth trial that lambs made satisfactory gains on corn stover (0.25 lbs. per day) and cane stover silages (0.23 lbs. per day) when supplemented with cottonseed meal. Baker (1943) reported that stover from some of the grain sorghums had a higher feeding value than generally recognized previously.

Colenbrander *et al*., (1971a) noted that although their fermentation patterns were similar, corn stover silage was usually less desirable than whole plant corn silage, as indicated by higher pH and titratable acidity and lower lactic acid levels. Colenbrander *et al*., (1971b) also noted that addition of increasing increments of urea, and to lesser extent ammonium polyphosphate, produced a linear increase ($P<.05$) in crude protein content of corn stover silage. Additions of urea tended to improve *in vitro* dry matter digestibility and structural composition of the stover as measured by cell wall constituents, acid detergent fiber and acid detergent lignin.

Oh, Weir and Longhurst (1971) pelleted cornstalks, rice straw and barley straw with additional nitrogen, phosphorous, and sulfur. Alfalfa was used as a positive control. The pelleted stovers had a lower apparent dry matter digestibility than alfalfa, but their calculated digestible energy values were in the recommended range for sheep maintenance rations (N.R.C., 1968).

Corn stover silage produced significantly less gain than corn silage, but it still provided sufficient energy for maintenance and limited growth when other ration nutrients were provided (Colenbrander, 1971a). Holstein heifers gained 0.89 kg per day on corn silage, 0.45

kg on corn stover silage and 0.50 kg on corn stover silage ensiled with 0.5% urea. Corn silage had a more desirable fermentation than either corn stover silage as measured by pH, titratable acidity and lactic acid content.

Chyba (1972) reported that milo stubble silage was an acceptable energy source for gestating ewes. In a second study, Chyba (1973) fed lambs: (1) forage sorghum silage, (2) milo stubble silage, (3) milo stubble silage ensiled with grain, (4) milo stubble silage ensiled with organic acids and (5) milo stubble pellets. None of the milo stubble silages supported satisfactory lamb performance. Lambs fed forage sorghum silage or milo stubble pellets gained faster, were more efficient, and consumed more feed than lambs fed the three milo stubble silages.

Albert et al., (1967a) fed husklage (ensiled husks and cobs), stalklage (ensiled stalks and leaves) and corn silage, all supplemented with soybean meal and vitamin A to pregnant beef heifers. Average daily gain (lb.) and dry matter digestibility (%) were: 0.73, 60.0; 0.11, 55.4; and 1.24, 65.0 for the husklage, stalklage and corn silage, respectively. In another study by Albert et al., (1967b), ewes fed cornstalks ensiled with urea or biuret maintained their body weight, while those fed cornstalks ensiled with soybean meal gained five lbs. per head during an 80-day trial. Dry matter digestibilities were 48.6, 48.4 and 50.3 percent for the urea, biuret and soybean meal supplemented silages respectively. All ewes were in positive nitrogen balance.

Cows fed the stalklage and urea for 50 days consumed 13.3 lbs. of dry matter daily and gained 11.2 lbs. (Albert et al., 1967c). Those fed stalklage and biuret consumed 12.0 lbs. of dry matter daily and gained 10.0 lbs.

Ward (1972) reported that cornstalks could be used effectively as the only energy source for mature gestating cows, but they must be supplemented for lactating animals. Gestating heifers gained 41 lbs. each in a 60-day trial on a stalklage ration supplemented with corn, natural protein, vitamin A and phosphorous. Stalklage-fed heifers, hay-fed heifers and heifers grazing cornstalks had similar calf birth weights.

Vetter (1971) reported that growing beef heifers grazing cornstalks gained 1.06 lb. per day. Mature cows gained 0.88 lb. per day.

Albert (1971) found corn stover met the daily energy needs of dry beef cows but was slightly deficient in protein, vitamin A, phosphorous and calcium. Vetter (1973) reported that phosphorous supplementation was needed if the residue feeds were to be a major portion of a beef cow ration.

Ummuna et al., (1972) observed that lambs fed corn cobs treated with 4.0% NaOH and supplemented with a corn gluten meal-urea mix gained slightly faster than lambs fed soybean meal (0.25 vs. 0.21 lb. per lamb per day). In a second similar trial by these authors, reverse results were observed.

Klopfenstein (1973) fed calves NaOH-treated husklage supplemented with soybean meal, urea and corn gluten meal-urea. Average daily gain (lb.) and feed per unit of gain were: 1.5, 8.8; 1.0, 13.1; and 1.3, 10.4, respectively.

Koers, Woods and Klopfenstein (1970) observed that steers fed untreated and 4.0% NaOH-treated corn stover silages gained 0.66 lb. and 0.90 lb., respectively. Koers, Prokop and Klopfenstein (1972) reported similar results with growing lambs.

EXPERIMENTAL PROCEDURE AND RESULTS

Numerous research reports have shown grain crop residues to be an acceptable source of energy when used in maintenance feeding programs for beef cows and ewes. These reports also show that crop residues are of low nutritive value, and in most instances they do not contain sufficient protein to meet the animal's requirement. No reports appear in the literature to indicate the feeding value of milo stover in growing rations for ruminants. Thus, it was the primary purpose of these experiments to determine the feeding value of milo stover when fed to growing beef heifers and lambs. Research has shown pelleting improves the nutritive value of low quality forages (such as prairie hay), so a second objective was to compare ensiled and pelleted milo stover. Since milo stover is variable in protein content, a third objective was to evaluate soybean meal, urea, biuret and a corn gluten meal-soybean meal-urea combination as nitrogen sources.

Statistical analyses of the data were by analysis of variance as described by Steele and Torrie (1960). When statistical significance occurred, Duncan's Multiple Range test as described by Steele and Torrie (1960) was used to determine difference between treatment means. Analysis of variance tables for all data appear in the Appendix.

Experiment I - Heifer Growth Trial 1 (1972-73)

Three objectives of this trial were: (1) to determine relative feeding value of milo stover and forage sorghum silage in rations for growing beef heifers; (2) to compare ensiled and pelleted milo stover; and (3) to evaluate an organic acid mixture as a preservative for forage sorghum silage. Rations and forage treatments compared were: (1) forage sorghum silage; (2) forage sorghum silage ensiled with organic acids; (3) milo stover pellets; (4) milo stover silage; and (5) milo stover silage plus rolled milo. Sixty-five Angus, Hereford and crossbred replacement heifer calves averaging 206.8 kg were randomly allotted by weight and breed to each of the five rations. There were 13 heifers per treatment in two pens of six and seven head.

Milo stover and forage sorghum were each harvested from a single source with a forage harvester equipped with a 7.62 cm, recutter screen. Milo stover was harvested October 25, 26 and 27, 1972 (after a killing frost) from grain sorghum that yielded 5,848 kg per hectare. Grain and stover moisture at harvest were approximately 18 and 70 percent, respectively. Milo stover pellets (0.66 cm) were processed by a commercial dehydrator and stored in a metal hopper bin. An organic acid mixture (60% acetic and 40% propionic acids) was applied to one silo of forage sorghum at 3.4 kg per metric ton of wet forage. Approximately 23 metric tons of each silage were ensiled in upright, concrete stave silos (3.1 x 15.2 m).

Rations 1, 2, 3 and 4 contained 76.0% of the appropriate forage, 12.0% dehydrated alfalfa pellets and 12.0% supplement (dry matter basis). Ration 5 was 57.8% stover silage, 18.2% rolled milo, 12.0% dehydrated alfalfa pellets and 12.0% supplement (dry matter basis). Rolled milo was added to ration 5 to assure an average daily gain of at least 0.68 kg. All rations were formulated to be equal in crude protein (12.5%), minerals and additives. Compositions of the supplements are shown in table 1. Supplement A was fed with rations 1-4; supplement B with ration 5. Heifers were fed twice daily. Water was available free choice. Major ration components were sampled every 14 days and frozen for analyses.

The trial started December 20, 1972 and lasted 114 days. Initial and final weights were taken after 15 hours without feed or water; 28-day intermediate weights were taken before the a.m. feeding.

Ration samples were composited, mixed and sub-sampled. Aliquots were dried to a constant weight at 50°C and ground to pass a 40 mesh screen. Proximate analyses were carried out on ration components (A.O.A.C., 1970). Analysis of cell wall constituents (CWC), acid detergent fiber (ADF) and lignin were determined for the forage samples using the technique of Goering and Van Soest (1970). Silage pH was established by extraction with distilled water (Barnett, 1954).

Composition of the four forage treatments is presented in table 2.

Heifer performance is shown in table 3. Heifers fed untreated and organic acid-treated forage sorghum silage and milo stover silage plus rolled milo (rations 1, 2 and 5) had a similar rate of gain, dry matter intake and feed efficiency. Heifers receiving milo stover silage (ration 4) gained less ($P<.05$) and those receiving milo stover pellets (ration 3) tended to gain less than those receiving any of the other three rations. Pelleting milo stover increased ($P<.05$) dry matter consumption when compared to milo stover silage; however, heifers fed

Table 1. Composition of the Supplements Fed in Experiment I[a]

Ingredient	Supplement A	Supplement B
	% (dry matter basis) %	
Soybean meal	77.27	62.00
Milo, rolled	5.55	21.57
Dehydrated alfalfa	10.00	10.00
Dried Masonex	1.00	1.00
Dicalcium phosphate	3.00	2.25
Salt	2.00	2.00
Trace mineral premix	0.50	0.50
Vitamin A premix[b]	0.33	0.33
Aureomycin[c]	0.35	0.35

[a]Fed as a 0.48 cm pellet

[b]Formulated to supply 30,000 I.U. per heifer per day

[c]Formulated to supply 70 mg per heifer per day

Table 2. Composition of the Four Forage Treatments in Experiment I

Item	Forage sorghum silage		Milo stover	
	Untreated	Organic acid-treated	Silage	Pellet
Dry matter, %	29.4	31.6	28.8	89.2
Ash, %	8.5	8.7	11.5	12.1
Crude protein, %	8.0	7.7	7.7	7.7
Crude fiber, %	21.6	23.5	30.8	31.5
Ether extract, %	1.8	2.1	1.7	2.0
NFE, %	60.1	58.0	48.3	46.7
CWC	50.4	60.0	63.3	70.3
ADF	32.2	32.4	42.4	47.5
Lignin	5.2	5.7	7.7	8.6
pH	4.10	3.90	4.05	---

Table 3. Heifer Performance from Experiment I[1]

	Treatment				
	Forage sorghum silage		Milo stover		
Item	Untreated	Organic acid-treated	Pellet	Silage	Silage + rolled milo
Ration number	1	2	3	4	5
Initial wt., kg	203.6	211.4	201.8	210.9	207.3
Final wt., kg	291.8	296.4	272.7	272.7	288.6
Avg. total gain, kg	88.2	85.0	70.9	61.8	81.4
Avg. daily gain, kg	0.77[a]	0.75[a,b]	0.62[b,c]	0.55[c]	0.71[a,b]
Avg. daily feed[2], kg					
silage &/or pellets	4.51	4.75	5.52	3.85	3.36
milo, rolled	---	---	---	---	1.10
dehy alf. pellets	0.79	0.79	0.88	0.68	0.77
supplement	0.77	0.77	0.85	0.67	0.75
total[3]	6.07[a,b]	6.31[a,b]	7.25[a]	5.20[b]	5.98[a,b]
	(2.44)	(2.48)	(3.06)	(2.16)	(2.41)
Feed/kg gain[2], kg	7.88[a]	8.41[a,b]	11.69[c]	9.45[b]	8.42[a,b]

[1]December 20, 1972 to April 14, 1973 (114 days)

[2]100% dry matter basis

[3]Value in parenthesis is dry matter intake as a % of body weight

[a,b,c]Means on the same line with different superscripts differ significantly ($P<.05$)

the pelleted stover ration were less efficient ($P<.05$) than heifers fed any of the other four rations. Animals fed stover silage were less efficient ($P<.05$) than those fed untreated forage sorghum.

Statistical analyses of the data appear in Appendix table 1.

<u>Experiment II - Lamb Growth Trial</u>

The objective of this trial was to evaluate two milo stover processing and storing methods upon feedlot performance of growing lambs fed four sources of supplemental nitrogen. Eight rations compared were: milo stover silage plus (1) soybean meal (SBM), (2) urea, (3) biuret, (4) corn gluten meal-soybean meal-urea (CGM-SBM-Urea); milo stover pellets plus (5) SBM, (6) urea, (7) biuret and (8) CGM-SBM-Urea. Ninety-six Rambouillet x Hampshire wether and ewe lambs averaging 27.4 kg were randomly allotted by weight and sex to each of the eight rations. There were 12 lambs per treatment in three pens of four head.

Milo stover was from the same source and harvested under the same conditions as described in Experiment I. Milo stover silage was treated with an organic acid mixture (60% acetic and 40% propionic acids) applied at 3.4 kg per metric ton of wet silage. Approximately 9 metric tons of silage was ensiled in an uncovered, upright, concrete stave silo (3.7 x 17.4 m).

All rations contained 87.0% of the appropriate forage and 13.0% supplement (dry matter basis). All rations were formulated to be equal in crude protein (12.5%), minerals and additives. Compositions of the supplements are shown in table 4. Supplement A was fed in rations 1 and 5; supplement B in rations 2 and 6; supplement C in

Table 4. Composition of the Supplements Fed in Experiment II

Ingredient	Supplement A	B	C	D
	%	%	%	%
	(Dry matter basis)			
Milo, rolled	5.28	80.54	77.77	36.56
Soybean meal	89.30	---	---	21.60
Urea	---	12.04	---	5.05
Biuret	---	---	14.81	---
Corn gluten meal	---	---	---	30.15
Dicalcium phosphate	1.25	3.25	3.25	2.47
Salt	1.90	1.90	1.90	1.90
Trace mineral premix	0.30	0.30	0.30	0.30
Auromycin[a]	0.77	0.77	0.77	0.77
Vitamin A premix[b]	0.19	0.19	0.19	0.19
Vitamin D premix[c]	0.01	0.01	0.01	0.01
Masonex	1.00	1.00	1.00	1.00

[a]Added to provide 27 mg per lamb daily

[b]Added to provide 3000 I.U. of vitamin A per lamb daily

[c]Added to provide 300 I.U. of vitamin D per lamb daily

rations 3 and 7; supplement D in rations 4 and 8. CGM and urea each provided one-third of the crude protein equivalent in supplement D. Lambs were fed twice daily. Water was available free choice. Major ration components were sampled weekly and frozen for analyses.

The growth trial started March 8, 1973 and lasted for 50 days. Initial and final weights of lambs were taken after 15 hours without feed and water; 14-day intermediate weights were taken before the a.m. feeding.

Chemical analyses of the forage treatments are shown in table 5.

Performance of lambs is shown in tables 6, 7 and 8.

Lambs receiving SBM and CGM-SBM-Urea supplemented rations had similar performance (table 7). Lambs fed urea gained slower ($P<.05$) and consumed less feed ($P<.05$) than lambs fed the other three sources of supplemental nitrogen. Lambs fed biuret gained slower ($P<.05$) than those fed SBM or CGM-SBM-Urea. Gain per unit of feed was greater ($P<.05$) for lambs fed SBM and CGM-SBM-Urea supplemented rations than for those fed urea or biuret supplemented rations.

Lambs fed the milo stover pellet rations gained faster ($P<.01$), consumed more feed ($P<.01$) and were more efficient ($P<.01$) than lambs fed the milo stover silage rations (table 8).

Statistical analyses of the data appear in Appendix table 2.

Experiment III - Lamb Metabolism Study

The objective of this study was to determine the influence of milo stover silage and pellets upon ration digestibility, nitrogen retention and rumen fermentation in growing lambs fed four sources of supplemental

Table 5. Composition of the Forage Treatments in Experiment II

Item	Milo stover	
	Silage	Pellets
Dry matter, %	28.5	91.0
Ash, %	13.2	12.4
Crude protein, %	8.8	8.1
Crude fiber, %	1.8	2.1
Ether Extract, %	31.3	30.0
NFE, %	44.9	47.4
CWC	65.4	69.3
ADF	43.6	42.2
Lignin	7.5	7.4
pH	4.2	---

Table 6. Performance of Growing Lambs Fed Two Sources of Milo Stover and Four Sources of Supplemental Nitrogen[1]

Item	Milo stover silage				Milo stover pellets			
	SBM	Urea	Biuret	CGM-SBM-Urea	SBM	Urea	Biuret	CGM-SBM Urea
No. of lambs	12	12	12	12	12	12	12	12
Initial wt, kg	27.0	27.7	27.0	27.3	28.3	27.3	27.6	27.3
Final wt, kg	28.3	27.6	27.9	29.6	34.9	30.9	32.1	33.5
Avg total gain, kg	1.32	-0.13	0.91	2.27	6.64	3.54	4.59	6.23
Avg daily gain, kg	0.026	-0.006	0.018	0.045	0.132	0.073	0.091	0.127
Avg daily feed,[2,3] kg	0.568 (2.05)	0.568 (2.05)	0.591 (2.16)	0.614 (2.16)	1.322 (4.19)	1.218 (4.19)	1.332 (4.46)	1.254 (4.13)
Gain/kg feed[2], kg	0.046	-0.011	0.030	0.073	0.100	0.060	0.068	0.101

[1]March 8, 1973 to April 27, 1973 (50 days)

[2]100% dry matter basis

[3]Value in parenthesis is dry matter intake as a % of body weight

Table 7. Effect of Source of Supplemental Nitrogen Upon Lamb Performance

Item	Source of nitrogen: SBM	Urea	Biuret	CGM-SBM Urea
No. of lambs	24	24	24	24
Avg daily gain, kg	0.082[a]	0.032[c]	0.055[b]	0.086[a]
Avg daily feed[d], kg	0.945[a]	0.891[b]	0.964[a]	0.932[a]
Gain/kg feed[d], kg	0.087[a]	0.036[c]	0.057[b]	0.092[a]

[a,b,c]Means on the same line with different superscripts differ significantly ($P < .05$)

[d]100% dry matter basis

Table 8. Effect of Source of Milo Stover Upon Lamb Performance

Item	Source of milo stover: Silage	Pellets
No. of lambs	48	48
Avg daily gain, kg	0.02[a]	0.11[b]
Avg daily feed[c], kg	0.59[a]	1.30[b]
Gain/kg feed[c], kg	0.04[a]	0.08[b]

[a,b]Means on the same line with different superscripts differ significantly ($P < .01$)

[c]100% dry matter basis

nitrogen. The eight rations fed were the same as those previously described in Experiment II.

The 24 Rambouillet x Hampshire wether lambs were selected from the lambs used in Experiment II. All lambs received approximately 700 g (dry matter basis) of the appropriate ration. Lambs were not randomly assigned to the eight rations; the three lambs fed each of the eight rations in the metabolism study also received the same rations during Experiment II. This resulted in a ration adjustment period of more than 50 days.

The lambs were fed in digestion crates designed for separation of urine and feces. A six-day crate adjustment period was followed immediately by two consecutive six-day collection periods. Lambs were shorn before the metabolism study to reduce wool contamination of urine and fecal collections. Urine was collected in plastic buckets containing 50 ml of 50% HCl to maintain acidity. Urine collections were diluted with water to the next highest kg and a 10% aliquot sample was taken and stored in glass bottles. Daily fecal collections were weighed and a 10% aliquot sample frozen. At the end of each six-day collection period, the feces and urine were composited for laboratory analyses. Approximately 200 g of the fecal material were placed in an aluminum pan and dried at 50^{o}C for 48 hours in a forced air oven. Feces were then ground through a 40 mesh screen in a Wiley mill in preparation for chemical analyses. Daily ration samples were taken during each collection period and a composite sample of each was handled in the same manner as the fecal samples.

The urine, dry feces and feed samples were analyzed for nitrogen by the Kjeldahl method as outlined by A.O.A.C. (1965). Dry matter determination on both the feces and feed was according to A.O.A.C. (1960).

Following the last day of the second collection period, rumen fluid samples were taken via a stomach tube using the suction strainer apparatus described by Raun and Burroughs (1962). Lambs were allowed access to feed for one hour prior to obtaining rumen samples at one, two and four hours after feeding. The strainer with sample tube attached was passed orally into the reticulo-rumen area of the stomach. The initial 10 to 20 ml of rumen fluid was discarded and served to flush the strainer and tube of any saliva or contaminating material. A 30 ml sample was drawn discharged into a plastic bag and pH determined immediately with a Beckman pH meter. One milliliter of a 5% solution of mercuric chloride was mixed with the sample to inhibit microbial activity. The samples were frozen until analyzed for ammonia-nitrogen and volatile fatty acids (total and partition). In the final preparation prior to analysis, the samples were centrifuged at 42,000 g for 10 minutes in a centrifuge. Ten parts of the supernatant was mixed with one part of a 50% sulphuric acid solution and allowed to stand at room temperature for 10 minutes. After a second centrifugation, the supernatant was collected and used for analysis.

Ammonia-nitrogen was determined by the microdiffusion method by Conway (1957). A 1 ml sample of rumen fluid was added to the outer diffusion chamber of the Obrink modified Conway unit. One milliliter of a 2% solution of boric acid, containing a mixture of methyl green and methyl red as an indicator, was added to the inner chamber. After 1 ml of saturated potassium carbonate solution was added to the outer chamber, the system was immediately closed. The lid chamber was lined with 1.5 ml of saturated potassium carbonate to prevent leakage of gas. The rumen fluid and potassium carbonate were allowed to mix on a bevel and·allowed to incubate for 90 minutes prior to titration wtih a standard solution of 0.1N sulphuric acid.

Gas chromatographic analysis was used to separate the volatile fatty acids as described by (Parks, 1970). Volatile fatty acids were separated on a 183.0 cm x 3.18 mm stainless steel column packed with 60-80 mesh Chromosorb 101, using a flash vaporization inlet, hydrogen flame detection, and an oven temperature of 109^{o} (isothermal). The carrier gas was nitrogen.

Ration digestibility and nitrogen retention data are shown in tables 9, 10 and 11. Results of the two collection periods are averaged for presentation.

Source of nitrogen had a significant effect on ration digestibility and nitrogen retention (table 10). Dry matter digestibility was higher ($P<.05$) for the SBM rations than the biuret rations. A significant ($P<.01$) treatment by period interaction was observed for dry matter digestibility. Crude protein digestibility was lowest ($P<.01$) in lambs fed biuret compared to lambs fed any of the other three sources of nitrogen. Lambs receiving CGM-SBM-Urea had a higher ($P<.01$) crude protein digestibility than lambs receiving SBM. Crude protein digesti-

Table 9. Effect of Source of Milo Stover and Source of Supplemental Nitrogen Upon Ration Digestibility and Nitrogen Retention in Lambs[1]

Item	Milo stover silage				Milo stover pellets			
	SBM	Urea	Biuret	CGM-SBM Urea	SBM	Urea	Biuret	CGM-SBM Urea
Dry matter intake, g/day	620.8	619.0	621.8	621.1	699.6	698.0	700.8	700.1
Digestibility								
Dry matter, %	50.6	49.3	47.4	50.2	52.1	48.8	49.5	51.3
Crude protein, %	63.8	65.6	60.8	66.5	60.9	62.7	59.4	64.5
Nitrogen retained								
N intake, g/day	13.91	14.38	15.02	14.91	14.11	14.59	15.18	15.11
N retained, g/day	0.54	-0.14	-0.61	0.52	0.76	-0.06	0.19	2.34

[1]Six lamb observations per treatment mean

Table 10. Effect of Source of Supplemental Nitrogen Upon Ration Digestibility and Nitrogen Retention in Lambs[1]

Item	Source of nitrogen			
	SBM	Urea	Biuret	CGM-Urea SBM
Dry matter intake, g/day	660.2	658.5	661.3	660.6
	Digestibility			
Dry matter, %	51.35[a]	49.03[a,b]	48.48[b]	50.77[a,b]
Crude protein, %	62.38[b]	64.16[a,b]	60.08[c]	65.46[a]
	Nitrogen retained			
N intake, g/day	14.01	14.49	15.01	15.01
N retained, g/day	0.65[b]	-0.10[c]	-0.21[c]	1.43[a]

[1] Twelve lamb observations per treatment mean

[a,b,c] Means on the same line with different superscripts differ significantly (P<.05)

Table 11. Effect of Source of Milo Stover Upon Ration Digestibility and Nitrogen Retention in Lambs[1]

Item	Source of roughage	
	Milo stover silage	Milo stover pellets
Dry matter intake, g/day	620.7	699.6
	Digestibility	
Dry matter, %	49.38	50.42
Crude protein, %	64.17[a]	61.87[b]
	Nitrogen retained	
N intake, g/day	14.55	14.75
N retained, g/day	0.08[a]	0.81[b]

[1]Twenty-four lamb observations per treatment mean

[a,b]Means on the same line with different superscripts differ significantly ($P<.01$)

bility and grams of nitrogen retained were lower for period one than period two ($P<.01$ and $P<.05$, respectively). Lambs fed CGM-SBM-Urea retained more nitrogen ($P<.05$) than lambs fed any of the other three sources of nitrogen, and those fed SBM retained more ($P<.05$) nitrogen than those fed either biuret or urea.

Lambs fed the milo stover pellet rations tended to have a higher dry matter digestibility, had a lower ($P<.01$) crude protein digestibility and retained more ($P<.01$) nitrogen as compared to lambs fed the milo stover silage rations (table 11).

Rumen fermentation data are present in table 12.

Rumen fluid pH values were significantly affected by source of nitrogen, source of roughage and sampling time. pH was lowest at hours one and two for the urea and milo stover silage rations ($P<.05$ and $P<.01$, respectively) than for either SBM, biuret and CGM-SBM-Urea rations or the milo stover pellet rations. Interactions between source of protein by time and source of roughage by time were significant ($P<.05$ and $P<.01$, respectively).

Rumen ammonia-nitrogen concentrations were higher ($P<.01$) for lambs fed urea than for lambs fed any of the other three sources of nitrogen. These concentrations were highest ($P<.01$) at hours one and two and lowest at hour four regardless of source of nitrogen. Ammonia-nitrogen was not significantly affected by any other source of variation tested.

Although total volatile fatty acid concentrations tended to be higher in lambs fed SBM and CGM-SBM-Urea rations as compared to lambs

Table 12. Fermentation Data for Lambs in Experiment III[1]

Hr. After Feeding	pH	NH_3-N μ grams/ml	Total VFA μ moles/ml	Molar Percent VFA C_2	C_3	C_4
		Milo stover silage + SBM				
1	6.54	58.15	79.0	63.2	27.7	9.1
2	6.64	142.10	74.2	64.9	25.8	9.3
4	6.98	56.23	80.1	68.3	23.0	8.7
		Milo stover silage + Urea				
1	6.68	209.09	92.1	64.7	27.8	7.5
2	6.76	180.67	74.9	65.3	26.3	8.4
4	6.87	62.58	73.3	67.9	23.4	8.7
		Milo stover silage + Biuret				
1	6.60	84.45	75.3	63.0	29.1	7.9
2	6.74	66.91	74.0	64.7	27.4	7.9
4	6.92	39.85	62.1	67.6	24.5	7.9
		Milo stover silage + CGM-SBM-Urea				
1	6.54	123.56	95.5	65.6	27.2	7.2
2	6.73	149.66	75.4	66.0	25.5	8.5
4	6.99	61.18	100.3	69.7	22.5	7.8

[1]Three lamb observations per treatment mean

Table 12. Fermentation Data for Lambs in Experiment III (cont.)[1]

Hr. After Feeding	pH	NH_3-N µ grams/ml	Total VFA µ moles/ml	Molar Percent VFA		
				C_2	C_3	C_4
			Milo stover pellets + SBM			
1	6.78	98.09	85.9	66.3	19.1	14.6
2	6.67	96.62	89.5	65.5	19.2	15.1
4	6.89	54.32	87.5	67.1	18.8	14.1
			Milo stover pellets + Urea			
1	6.99	161.93	65.8	66.1	21.6	12.2
2	6.93	217.91	67.7	64.8	22.4	12.8
4	6.87	73.49	78.2	67.3	21.2	11.5
			Milo stover pellets + Biuret			
1	6.77	73.49	93.0	65.9	20.6	13.5
2	6.79	94.62	76.1	64.9	20.5	14.6
4	6.93	69.67	77.2	66.4	20.4	13.2
			Milo stover pellets + CGM-SBM-Urea			
1	6.78	155.59	65.3	64.3	20.8	14.9
2	6.73	146.81	87.9	66.0	19.7	14.3
4	6.89	65.62	84.3	68.4	19.0	12.6

[1]Three lamb observations per treatment mean

fed urea and biuret rations, none of the sources of variation tested were statistically significant.

Molar % acetate was higher (P<.01) at hour four than hours one and two; however, neither source of nitrogen nor source of roughage significantly affected acetate values. Molar % propionate was highest for lambs fed urea or biuret and milo stover silage rations (P<.05 and P<.01, respectively) than for lambs fed SBM or CGM-SBM-Urea and milo stover pellet rations. Molar % propionate decreased (P<.01) from hour one to hour four, and a source of roughage by time interaction (P<.01) was also observed. Molar % butyrate was higher (P<.01) for lambs receiving SBM compared to those receiving urea. Lambs fed milo stover pellets had a higher (P<.01) molar % butyrate than those fed milo stover silage. A source of nitrogen by source of roughage interaction (P<.05) was observed for molar % butyrate. None of the other sources of variation tested for molar % volatile fatty acids were statistically significant.

Statistical analysis of the data appear in Appendix tables, 3, 4 and 5.

<u>Experiment IV - Heifer Growth Trial 2 (1973-74)</u>

Results of Heifer Growth Trial 1 (1972-73) showed heifers receiving milo stover silage or pellet rations gained more than predicted gains using average net energy values for both animal requirements and ration components (N.R.C., 1970). Therefore, the objective of this trial was to re-evaluate the relative feeding value of milo stover and forage sorghum silage in rations for growing beef heifers.

Rations (forage treatment and supplemental nitrogen) compared were: (1) milo stover silage plus SBM, (2) milo stover silage plus CGM-SBM-Urea, (3) milo stover pellets plus SBM and (4) forage sorghum silage plus SBM. Seventy-two Angus, Hereford and crossbred replacement heifer calves averaging 209.2 kg were randomly allotted by weight and breed to each of the four rations. There were 18 heifers per treatment in three pens of six head.

Milo stover and forage sorghum were harvested, processed and stored in the fall of 1973 under similar conditions as described in Experiment I.

All rations contained 72.4% of the appropriate forage, 13.8% dehydrated alfalfa pellets and 13.8% supplement (dry matter basis). All rations were formulated to be equal in crude protein (12.5%), minerals and additives. Composition of the supplements are shown in table 13. Supplement A was fed in rations 1, 3 and 4; supplement B in ration 2. CGM and urea each provide one-third of the crude protein equivalent in supplement B. Heifers were fed twice daily. Water was available free choice. The growth trial started December 7, 1973 and lasted for 98 days. Initial and final weights of heifers were taken after 15 hours without feed or water; 42-day intermediate weights were taken before the a.m. feeding.

Major ration components were collected every 14 days and frozen for analysis. Samples were handled and chemical analyses were by the same methods as described in Experiment 1.

Composition of the three forage treatments is presented in table 14.

Table 13. Composition of the Supplements Fed in Experiment IV[a]

Ingredient	Supplement A	Supplement B
	% (dry matter basis) %	
Soybean meal	74.27	14.70
Corn gluten meal	---	21.65
Dehydrated alfalfa	10.00	10.00
Milo, rolled	10.00	41.87
Urea	---	4.55
Dicalcium phosphate	3.00	4.50
Salt	2.00	2.00
Trace mineral premix	0.05	0.05
Vitamin A premix[b]	0.33	0.33
Aureomycin[c]	0.35	0.35

[a]Fed as a 0.48 cm pellet

[b]Formulated to supply 30,000 I.U. per heifer per day

[c]Formulated to supply 70 mg per heifer per day

Table 14. Composition of the Three Forage Treatments in Experiment IV

Item	Milo stover Silage	Milo stover Pellets	Forage sorghum silage
Dry matter, %	29.9	93.3	26.1
Ash, %	15.5	13.3	8.6
Crude protein, %	6.0	5.0	7.6
Crude fiber, %	28.7	28.7	26.2
Ether extract, %	2.2	1.5	2.6
NFE, %	47.6	51.5	55.0
pH	4.9	---	4.3

Heifer performance is shown in table 15. Heifers fed forage sorghum silage (ration 4) gained faster ($P<.05$) and required less feed per unit of gain than heifers fed any of the three milo stover rations. Differences in average daily gain among the three milo stover rations were not significant. Heifers receiving milo stover pellets (ration 3) tended to gain faster than those receiving milo stover silage (rations 1 and 2). Pelleting milo stover increased ($P<.05$) dry matter consumption over either of the two milo stover silage rations or the forage sorghum silage ration. However, heifers fed milo stover pellets also required more feed per unit of gain ($P<.05$) than heifers fed milo stover silage plus CGM-SBM-Urea (ration 2).

Statistical analysis of the data appears in Appendix table 6.

Experiment V - Lamb Intake Study

In the Lamb Growth Trial dramatic differences in dry matter intake were observed between the pelleted and ensiled milo stover rations. In the Lamb Metabolism Study, dry matter intake was held constant at approximately the level of intake of lambs receiving milo stover silage. Therefore, the objective of this study was to determine the influence of level of milo stover pellet intake upon ration digestibility and nitrogen retention in growing lambs.

The ration fed was identical to ration 5 previously described in Experiment II. This ration fed at three levels of dry matter intake (approximately 700, 1000 and 1300 g/lamb/day) constituted the three treatments. The 12 wether lambs used in this study were the same lambs

Table 15. Heifer Performance from Experiment IV[1]

Item	Forage Treatment and Source of Supplemental Nitrogen: Milo stover: Silage + SBM	Milo stover: Silage + CGM-SBM-Urea	Milo stover: Pellets + SBM	Forage sorghum silage + SBM
Ration number				
Initial wt., kg	210.5	209.1	211.4	205.9
Final wt., kg	246.4	250.9	260.9	278.6
Avg total gain, kg	35.9	41.8	49.5	72.7
Avg daily gain, kg	0.37[b]	0.43[b]	0.51[b]	0.74[a]
Avg daily feed[2], kg				
silage &/or pellets	3.64	3.81	6.04	4.16
dehy alf. pellets	.69	.72	1.15	.79
supplement	.69	.72	1.15	.79
total[3]	5.02[c] (2.20)	5.25[c] (2.28)	8.34[a] (3.53)	5.74[b] (2.37)
Feed/kg gain[2], kg	14.01[a,b]	12.34[b]	16.82[a]	7.75[c]

[1] December 7, 1973 to March 15, 1974 (98 days)

[2] 100% dry matter basis

[3] Value in parenthesis is dry matter intake as a % of body weight

[a,b,c] Means on the same line with different superscripts differ significantly (P<.05)

from Experiment III that had received milo stover pellets during the Lamb Metabolism Study. Lambs were randomly allotted by weight to the three milo stover pellet treatments with 4 lambs per treatment. A single 10-day prefeeding period was followed immediately by a six-day collection period. Collection and sampling procedures were identical to those described in Experiment III.

Ration digestibility and nitrogen retention data are shown in table 16. None of the differences in dry matter or crude protein digestibilities were significant. However, both digestion coefficients tended to decrease as the level of dry matter intake increased. There was a significant ($P<.05$) linear increase in grams of nitrogen retained as the level of dry matter and nitrogen intake increased.

Statistical analysis of the data appears in Appendix table 7.

Table 16. Effect of Three Levels of Milo Stover Pellet Intake Upon Ration Digestibility and Nitrogen Retention in Lambs[1]

Item	Level of intake		
	700 g	1000g	1300g
Dry matter intake, g/day	689.5	984.6	1280.6
Intake, g/wt. $kg^{0.75}$	56.7	81.9	108.1
	Digestibility		
Dry matter, %	52.9	51.3	51.0
Crude protein, %	63.0	63.0	61.4
	Nitrogen retained		
N intake, g/day	13.01	18.57	24.18
N retained, g/day	0.83[c]	3.66[b]	6.00[a]

[1]Four lamb observations per treatment mean

[a,b,c]Means on the same line with different superscripts differ significantly ($P<.05$)

DISCUSSION

Results of the two heifer trials indicate that milo stover is a questionable energy source when fed in growing rations. As expected, heifers fed forage sorghum silage had greater performance than heifers fed milo stover. These results agree with data in the literature that compared corn plant residue and whole plant corn silage. Colenbrander (1971a) reported that Holstein heifers fed corn stover silage gained less than those fed corn silage. Albert et al. (1967a) found that heifers fed husklage (ensiled husk and cobs) and stalklage (ensiled stalks and leaves) had decreased performance compared to those receiving corn silage.

In both heifer trials, pelleting milo stover increased dry matter intake but resulted in poorer feed conversion compared to stover silage. However, heifers fed stover pellets tended to gain faster than those fed stover silage. Recent reports in the literature have not established a trend in the effect of pelleting the whole corn plant upon gain, intake and efficiency in growing beef cattle (Karn et al., 1974; Hendrix and Klopfenstein, 1973).

Addition of organic acids to forage sorghum silage did not improve its feeding value. This agrees with data reported by Bolsen, Chyba and Riley (1972).

Results of the lamb growth trial indicate that pelleting milo stover improves its feeding value when compared to stover silage. Lambs fed milo stover pellets gained faster and consumed more dry matter than lambs fed milo stover silage. In contrast to the heifer growth trials, pelleting milo stover also improved feed efficiency in lambs over milo stover silage. Chyba (1973) obtained similar results when comparing milo stover pellets and silage. In both heifer trials reported herein, pelleting increased intake about 50 percent over silage; however, in the lamb growth trial, intake was increased by about 100 percent by pelleting the milo stover.

In all three growth trials, pelleting milo stover produced a marked increase in consumption. Lloyd et al. (1960) and O'Dell et al. (1962) observed increased consumption when forage particle size was reduced by pelleting. Weeb and Cmarik (1957) reported a 50% increase in daily dry matter intake when a pelleted timothy-alfalfa ration was fed to steer calves. In general, data in the literature indicates that the value of a low quality forage is influenced by the physical form in which it is fed. However, pelleting does not always improve forage intake or animal performance. Meyer et al. (1959) observed no change in the TDN values when pelleted alfalfa hay was compared to chopped alfalfa hay. Although level of milo stover pellet intake did not significantly affect dry matter or crude protein digestibilities in Experiment V, there was a trend for both digestion coefficients to decrease as the level of dry matter intake increased. These results probably explain why heifers fed stover pellets gained faster but were less efficient than heifers fed stover silage: pelleting increased intake and decreased digestibility; however, the decrease in digestibility was more than compensated for by the increase in intake.

Milo stover (silage or pellets) in the two heifer trials was harvested, stored and fed under nearly identical conditions and procedures. The heifers used were from the same cow herd and received the same pre-trial treatment. Why, then, did heifers fed milo stover silage or pellet rations (without additional grain) have a higher performance in trial I (1972-73) than trial II (1973-74)? When gains were predicted using animal energy requirements and milo stover energy content values by N.R.C. (1970), gains were higher than expected in 1972-73 and lower than expected in 1973-74. Differences in severity of the weather during the winter months could account for part of this difference in performance. Heifers in trial 1 were weighed off test April 14; heifers in trial 2 were weighed off test on March 15. Since gain tended to improve toward the latter stages in both trials, differences in gain between the two years might have narrowed if heifers in trial 2 had been fed an additional 30 days. In vivo in vitro digestibilities were not determined for any of the forage treatments. Chemical composition of the stovers fed were not greatly different. In 1972-73, crude protein and crude fiber were both higher than similar values for 1973-74. Although data in the literature is limited, milo stover composition can be quite variable (Perry and Ward, 1973; Vetter, 1973; and Vanderlip, Schnieder and Bolsen, 1974).

In both the lamb growth trial and metabolism study, SBM and CGM-SBM-Urea supplements were superior to urea and biuret supplements. These results agree with numerous reports comparing SBM (or other plant proteins), biuret and urea supplements fed in low-energy growing or maintenance rations. In heifer growth trial 2, performance of animals fed milo stover silage and the CGM-SBM-Urea supplement was similar to that of animals fed milo stover silage and the SBM supplement.

Lambs fed milo stover pellets retained more nitrogen than those fed stover silage in the metabolism study. The data reported herein does not provide a clear explanation for this observation. An attempt was made to equalize feed intake, but lambs fed pellets actually consumed 12 percent more dry matter than those fed silage. Dry matter digestibility was not influenced by source of roughage (pellets or silage) and, as expected, crude protein digestibility was lower in lambs fed the pelleted rations. It seems unlikely that the differences in intake could account for all of the difference in nitrogen retention between milo stover pellet and silage fed lambs.

Fermentation data from the metabolism study indicated that lambs receiving urea had higher rumen ammonia-nitrogen and pH values at hours one and two postfeeding than lambs receiving any of the other three sources of nitrogen. These results agree with many reports of the literature (Briggs, 1967; Oltjen, 1969). Total volatile fatty acid concentration was not significantly affected by ration treatments; however, molar % propionate was higher in the silage fed lambs and molar % butyrate was higher in the pellet fed lambs. Wright, Pope and Phillips (1968) reported higher propionate and butyrate values in lambs fed pelleted hay versus long hay. Ensor, Shaw and Tellechea (1959) and Woods and Luther (1962) observed that pelleted rations containing high roughage levels generally did not alter rumen fermentation in lambs.

SUMMARY

Two heifer growth trials were conducted to determine the feeding value of milo stover silage and pellets. Influence of source of milo stover (silage or pellet) and source of supplemental nitrogen upon lamb performance, ration digestibility, nitrogen retention and rumen fermentation was determined in a lamb growth trial and metabolism study. Sources of nitrogen evaluated were soybean meal (SBM), urea, biuret and corn gluten meal-soybean meal-urea combination (CGM-SBM-Urea). A lamb intake study was conducted to determine the influence of level of milo stover pellet intake upon ration digestibility and nitrogen retention.

In the two heifer trials, animals fed forage sorghum silage had greater performance than animals receiving the milo stover rations. Pelleting milo stover increased ($P<.05$) dry matter intake but resulted in poorer feed conversion compared to any of the other rations. However, heifers fed stover pellets tended to gain faster than those fed stover silage. Adding organic acids to forage sorghum silage did not improve its feeding value. In the second heifer trial, animals fed stover silage supplemented with CGM-SBM-Urea or SBM had similar performance.

In the lamb growth trial, lambs fed milo stover pellets gained faster and more efficiently ($P<.01$) than lambs receiving milo stover silage. Pelleting increased dry matter intake by approximately 100% compared to silage. Lambs fed urea gained slower ($P<.05$) and consumed less feed ($P<.05$) than lambs receiving any of the other three sources of nitrogen. Lambs receiving SBM or CGM-SBM-Urea had similar performance and outperformed those receiving biuret.

In the lamb metabolism study, both source of roughage and source of nitrogen significantly affected dry matter and crude protein digestibilities and nitrogen retention. Lambs fed SBM or CGM-SBM-Urea retained more ($P<.05$) nitrogen than lambs fed urea or biuret; animals fed stover pellets retained more ($P<.01$) nitrogen than animals fed stover silage. Rumen pH and ammonia-nitrogen were higher at hours one and two post feeding in lambs fed urea compared to lambs fed any of the other three sources of nitrogen. Total volatile fatty acid concentration was not significantly affected by ration treatments; however, molar % propionate and butyrate were affected by sources of roughage and nitrogen.

In the lamb intake study, none of the differences in dry matter or crude protein digestibilities were significant. However, both digestion coefficients tended to decrease as the level of dry matter intake increased. A significant linear increase ($P<.05$) in grams of nitrogen retained occurred when the level of dry matter intake increased.

From these results it is questionable whether milo stover silage or pellet rations would support acceptable or economical performance in growing heifers and lambs.

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APPENDIX

Table 1. Analysis of Variance for Heifer Performance Data in Experiment I.

Source of variation	d.f.	Mean square: Average daily gain	Mean square: Average daily feed	Mean square: Feed per unit of gain
Total	9			
Treatment	4	0.0854[a]	5.2300[a]	4.6080[a]
Pen	1	0.0065	0.5560	0.0220
Treatment x pen	4	0.0117	0.9880	0.3036

[a]$P<.05$

Table 2. Analysis of Variance for Lamb Performance Data in Experiment II.

Source of variation	d.f.		Mean square: Average daily gain	Average daily feed	Feed per unit of gain
Total	23				
Treatment	7		0.0368[b]	2.0767[b]	0.0037[b]
roughage		1	0.2054[b]	13.9948[b]	0.0122[b]
nitrogen		3	0.0157[b]	0.0323[b]	0.0042[b]
roughage x nitrogen		3	0.0018	0.1485[b]	0.0004
Pen	2		0.0118[b]	0.0036	0.0041[b]
Treatment x pen	14		0.0010	0.0052	0.0006

[b]$P<.01$

Table 3. Analysis of Variance of Nitrogen Retention and Digestibility Data from Experiment III.

Source of variation	d.f.		Mean square gN retained	Dry matter	Crude protein
Total	47				
Treatment	7		4.69[b]	13.14	37.70[b]
roughage		1	6.37[b]	12.71	63.50[b]
nitrogen		3	6.96[b]	22.54[a]	65.29[b]
roughage x nitrogen		3	1.96	3.89	1.52
Period	1		5.48[a]	14.41	179.59[b]
Treatment x period[c]	7		0.47	6.35[b]	1.59
Error	32		0.21	1.82	5.17

[a]$P<.05$

[b]$P<.01$

[c]Used to perform test of significance for dry matter digestibility

Table 4. Analysis of Variance of Rumen Fermentation Data From Experiment III.

Source of variation	d.f.	Mean square pH	Mean square NH_3-N	Mean square Total VFA
Total	71			
Protein	3	0.0341[a]	22836.4[b]	394.12
Roughage	1	0.1309[b]	981.8	0.47
Time	2	0.2897[b]	38991.3[b]	104.32
Protein x roughage	3	0.0127	232.1	673.67
Protein x time	6	0.0265[a]	4298.4	190.46
Roughage x time	2	0.1233[b]	2912.0	311.08
Protein x roughage x treatment	6	0.0032	1306.6	303.45
Error	48	0.0099	2220.9	244.14

[a]P<.05

[b]P<.01

Table 5. Analysis of Variance of Molar % Volatile Fatty Acids of Rumen Samples from Experiment III.

Source of variation	d.f.	Mean square Acetate	Mean square Propionate	Mean square Butyrate
Total	71			
Protein	3	4.76	11.32[a]	8.66[b]
Roughage	1	0.59	560.57[b]	519.49[b]
Time	2	61.20[b]	43.43[b]	3.98
Protein x roughage	3	2.83	5.54	4.13[a]
Protein x time	6	1.21	0.39	0.37
Roughage x time	2	10.81	22.89[b]	3.09
Protein x roughage x treatment	6	2.21	0.31	0.91
Error	48	4.52	3.52	1.45

[a]$P<.05$

[b]$P<.01$

Table 6. Analysis of Variance for Heifer Performance Data in Experiment IV.

Source of variation	d.f.	Mean square: Average daily gain	Mean square: Average daily feed	Mean square: Feed per unit of gain
Total	11			
Treatment	3	0.3950[a]	34.0352[b]	43.3260[b]
Pen	2	0.0240	0.0450	5.8400
Treatment x pen	6	0.0134	0.7540	2.0050

[a]P<.05

[b]P<.01

Table 7. Analysis of Variance of Nitrogen Retention and Digestibility Data from Experiment V

Source of variation	d.f.	Mean square: gN retained	Mean square: Dry matter	Mean square: Crude protein
Total	11			
Dry matter intake	2	25.4084[b]	3.9404	3.1514
Weight	1	0.0601	8.4957	1.9485
Error	8	0.6231	1.4987	5.0158

[b]P<.01

MILO STOVER AS AN ENERGY SOURCE
FOR GROWING BEEF HEIFERS AND LAMBS

by

GARY QUIN BOYETT

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Two heifer growth trials were conducted to determine the feeding value of milo stover silage and pellets. Influence of source of milo stover (silage or pellet) and source of supplemental nitrogen upon lamb performance, ration digestibility, nitrogen retention and rumen fermentation was determined in a lamb growth trial and metabolism study. Sources of nitrogen evaluated were soybean meal (SBM), urea, biuret and corn gluten meal-soybean meal-urea combination (CGM-SBM-Urea). A lamb intake study was conducted to determine the influence of level of milo stover pellet intake upon ration digestibility and nitrogen retention.

In the two heifer trials, animals fed forage sorghum silage had greater performance than animals receiving the milo stover rations. Pelleting milo stover increased ($P<.05$) dry matter intake but resulted in poorer feed conversion compared to any of the other rations. However, heifers fed stover pellets tended to gain faster than those fed stover silage. Adding organic acids to forage sorghum silage did not improve its feeding value. In the second heifer trial, animals fed stover silage supplemented with CGM-SBM-Urea or SBM had similar performance.

In the lamb growth trial, lambs fed milo stover pellets gained faster and more efficiently ($P<.01$) than lambs receiving milo stover silage. Pelleting increased dry matter intake by approximately 100% compared to silage. Lambs fed urea gained slower ($P<.05$) and consumed less feed ($P<.05$) than lambs receiving any of the other three sources of nitrogen. Lambs receiving SBM or CGM-SBM-Urea had similar performance and outperformed those receiving biuret.

In the lamb metabolism study, both source of roughage and source of nitrogen significantly affected dry matter and crude protein digestibilities and nitrogen retention. Lambs fed SBM or CGM-SBM-Urea retained more ($P<.05$) nitrogen than lambs fed urea or biuret; animals fed stover pellets retained more ($P<.01$) nitrogen than animals fed stover silage. Rumen pH and ammonia-nitrogen were higher at hours one and two post feeding in lambs fed urea compared to lambs fed any of the other three sources of nitrogen. Total volatile fatty acid concentration was not significantly affected by ration treatments; however, molar % propionate and butyrate were affected by sources of roughage and nitrogen.

In the lamb intake study, none of the differences in dry matter or crude protein digestibilities were significant. However, both digestion coefficients tended to decrease as the level of dry matter intake increased. A significant linear increase ($P<.05$) in grams of nitrogen retained occurred when the level of dry matter intake increased.

From these results it is questionable whether milo stover silage or pellet rations would support acceptable or economical performance in growing heifers and lambs.